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**Tatzel et al.**

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(54) **PROVIDING A USER INTERFACE FOR DEVICES OF A HOME AUTOMATION SYSTEM**

(58) **Field of Classification Search**  
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See application file for complete search history.

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(56) **References Cited**

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U.S. PATENT DOCUMENTS

6,756,998	B1	6/2004	Bilger
7,930,644	B2	4/2011	Silva et al.
8,473,325	B2	6/2013	Barnhill, Jr. et al.
2006/0080408	A1	4/2006	Istvan et al.
2007/0112939	A1	5/2007	Wilson et al.
2007/0142022	A1	6/2007	Madonna et al.
2008/0127063	A1*	5/2008	Silva et al. .... 717/107
2013/0283025	A1	10/2013	Madonna et al.

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OTHER PUBLICATIONS

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

U.S. Appl. No. 13/923,826, Filed: Jun. 21, 2013 by Robert Madonna et al. for a Configuration Connection Device, 1-28.  
U.S. Appl. No. 14/190,984, Filed: Feb. 26, 2014 by Robert Madonna et al. for a User Generated Virtual Room-Based User Interface, 1-32.  
U.S. Appl. No. 14/282,734, Filed: May 20, 2014 by David W. Tatzel, et al. for an Automatic Configuration of Control Device User Interface in a Home Automation System, 1-30.

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\* cited by examiner

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**Related U.S. Application Data**

(63) Continuation of application No. 14/282,734, filed on May 20, 2014.

(57) **ABSTRACT**

(51) **Int. Cl.**

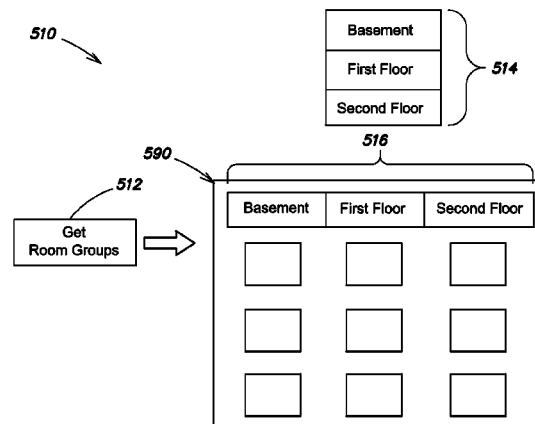
<b>G06F 3/0484</b>	(2013.01)
<b>H04L 12/28</b>	(2006.01)
<b>H04L 12/24</b>	(2006.01)
<b>G06F 17/30</b>	(2006.01)
<b>G06F 3/14</b>	(2006.01)

In one embodiment, a custom user interface (UI) is provided for a plurality of devices of a home automation system within a structure. A configuration database is constructed that stores logical representations. The logical representations stored in the configuration database to include components, services, rooms, and zones. A mobile application (app) finds and connects to the configuration database. The mobile app then queries the configuration database. Based on the querying, the mobile app presents a custom user interface (UI) to the user on a display screen, wherein the custom UI is usable to control one or more of the plurality of devices of the home automation system.

(52) **U.S. Cl.**

CPC ..... **H04L 12/282** (2013.01); **G06F 3/0484** (2013.01); **G06F 3/14** (2013.01); **G06F 17/30** (2013.01); **G06F 17/30477** (2013.01); **H04L 12/28** (2013.01); **H04L 12/281** (2013.01); **H04L 41/22** (2013.01)

**22 Claims, 8 Drawing Sheets**



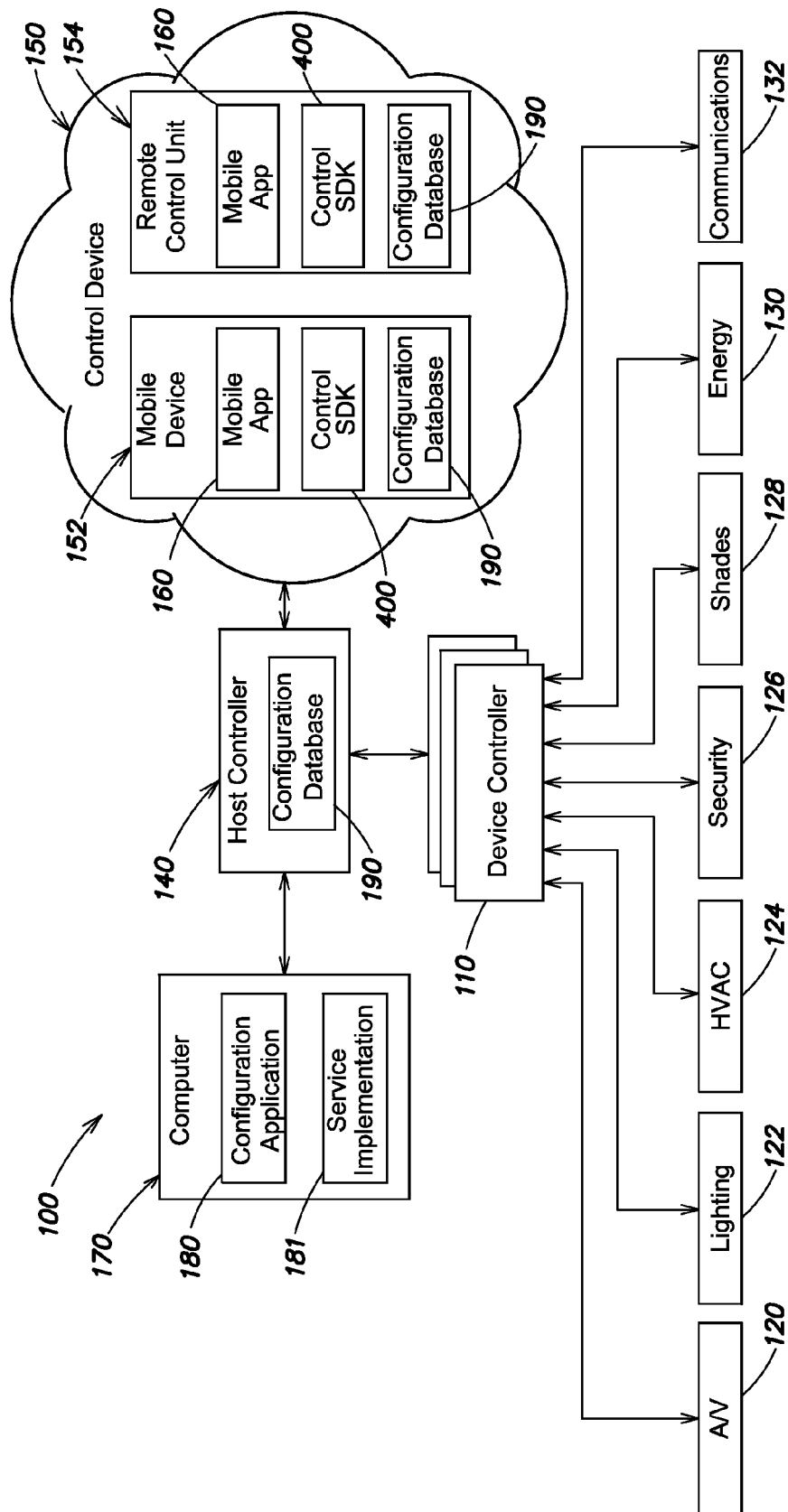


FIG. 1

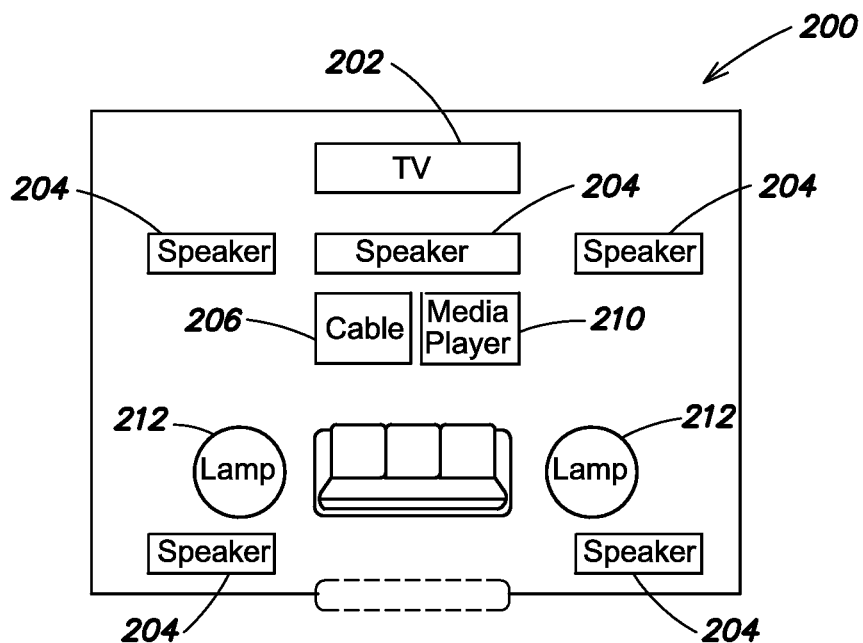


FIG. 2A

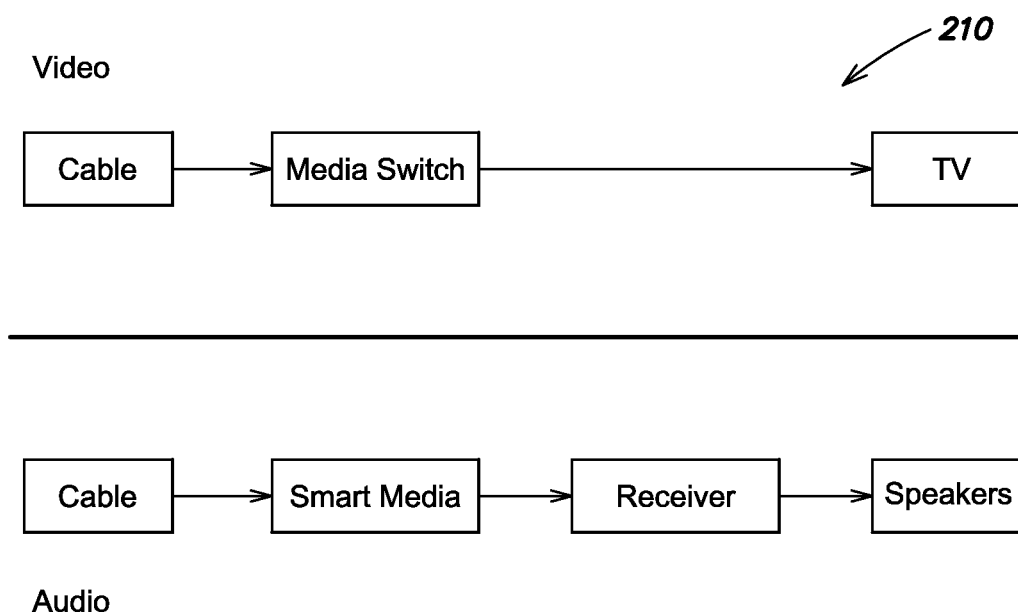
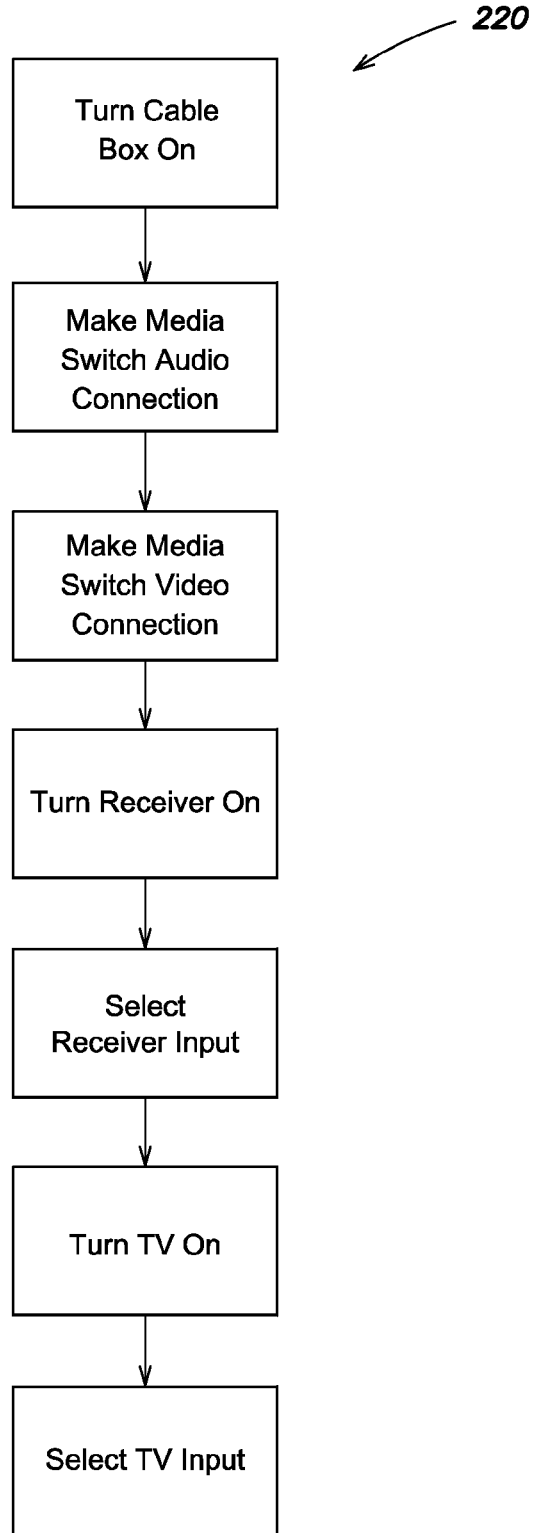
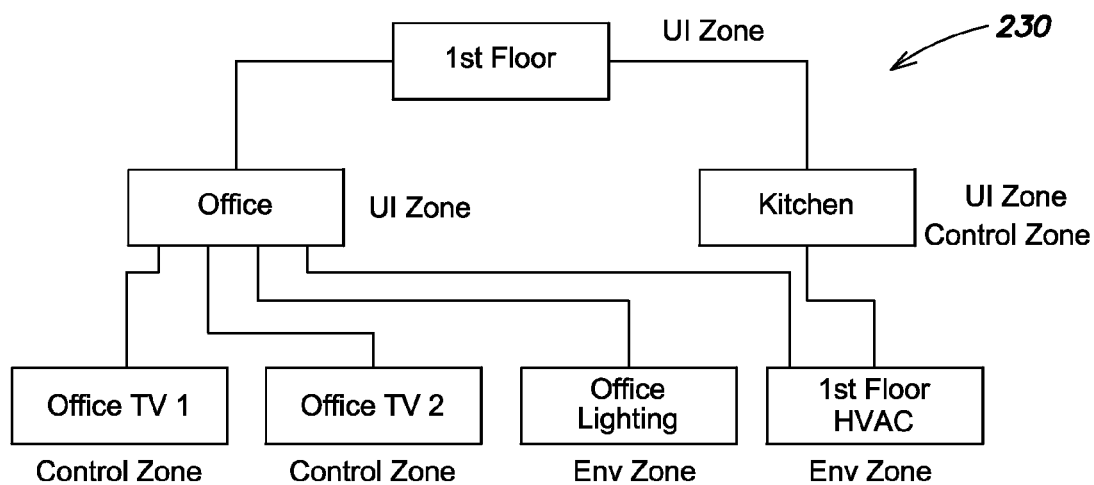


FIG. 2B

**FIG. 2C**

**FIG. 2D**

Rooms				310
ID	Name (Unique)			

RoomGroups				320
ID	Name			

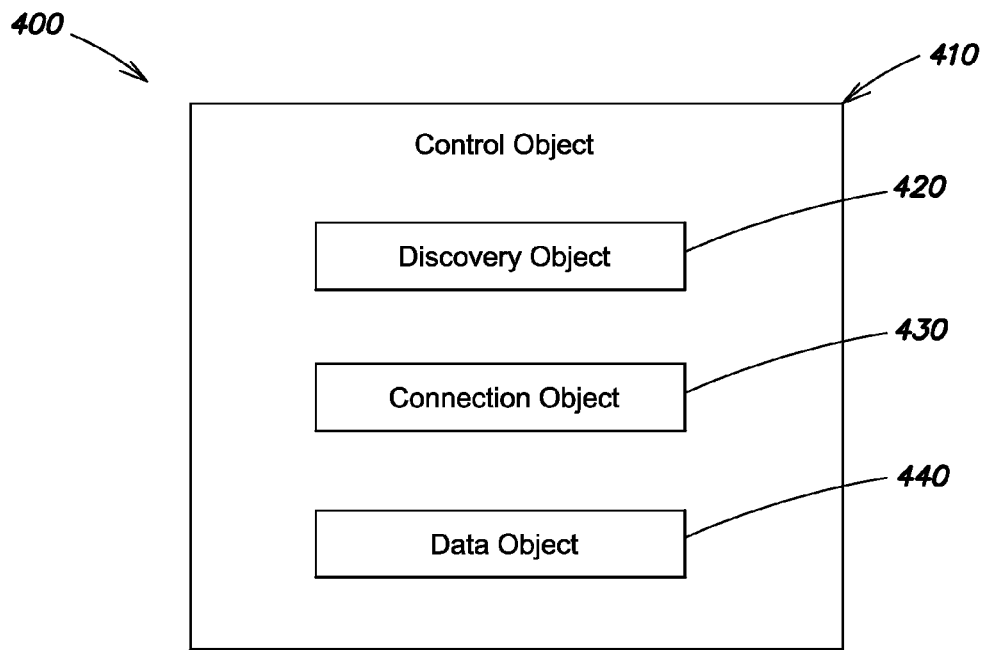
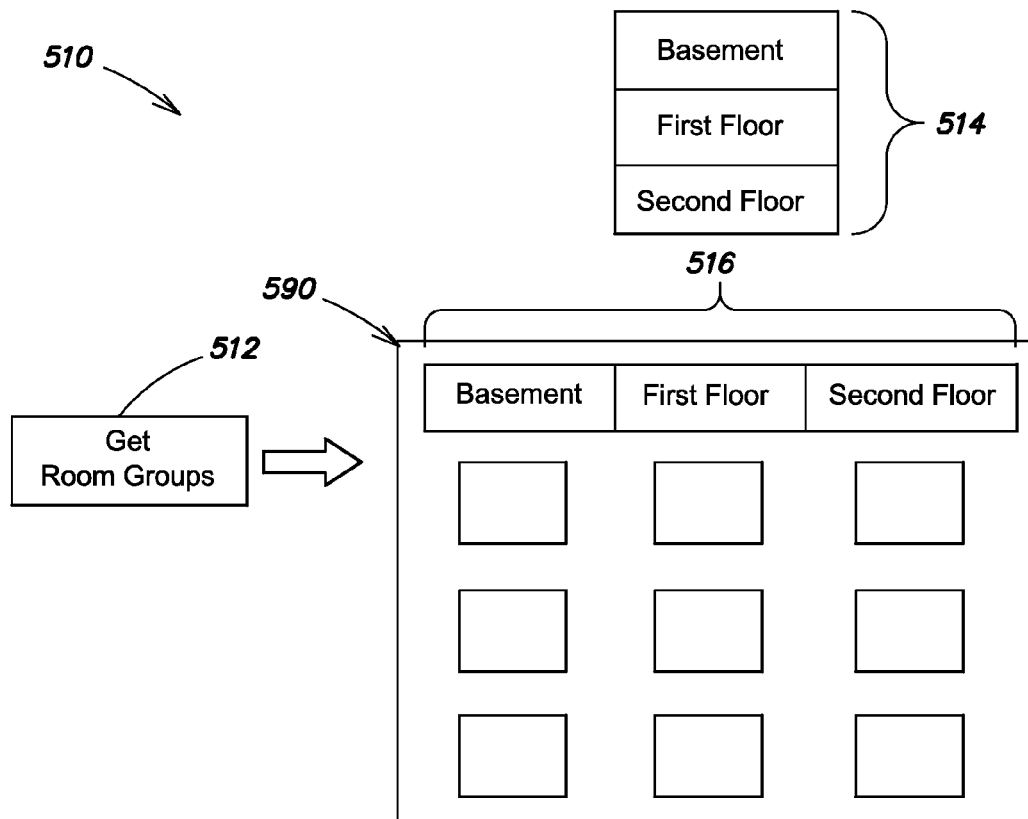
Zones				330
ID	Name	Type		

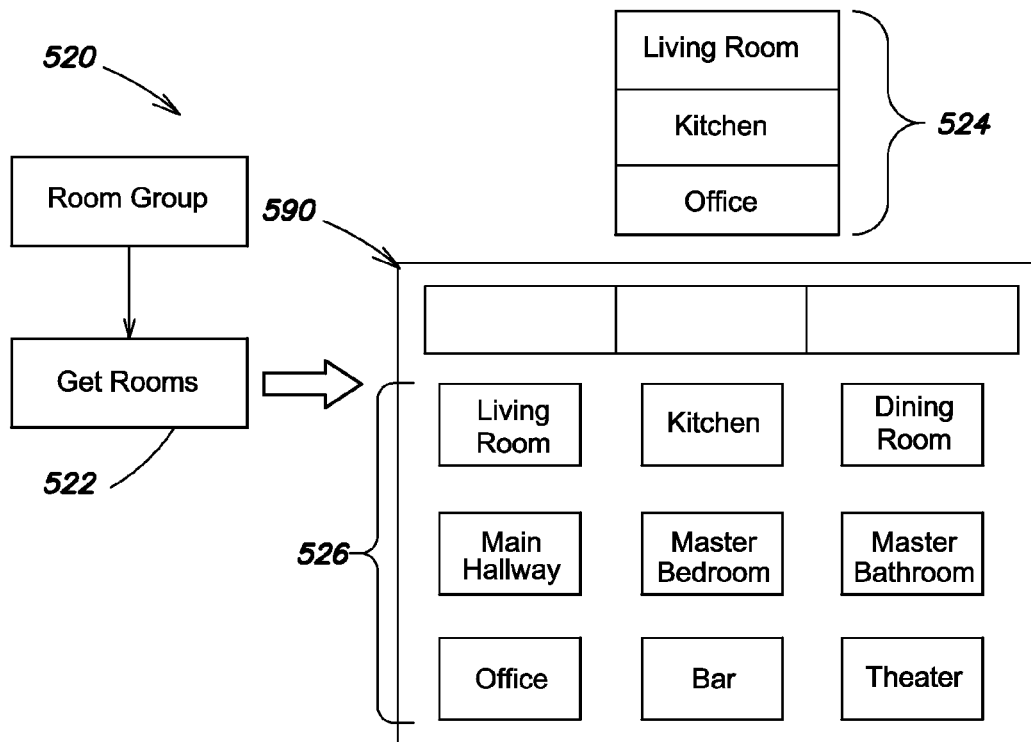
RoomGroupMap				340
ID	RoomID	GroupID		

ZoneServiceMap				350
ID	Zone	ServiceID		

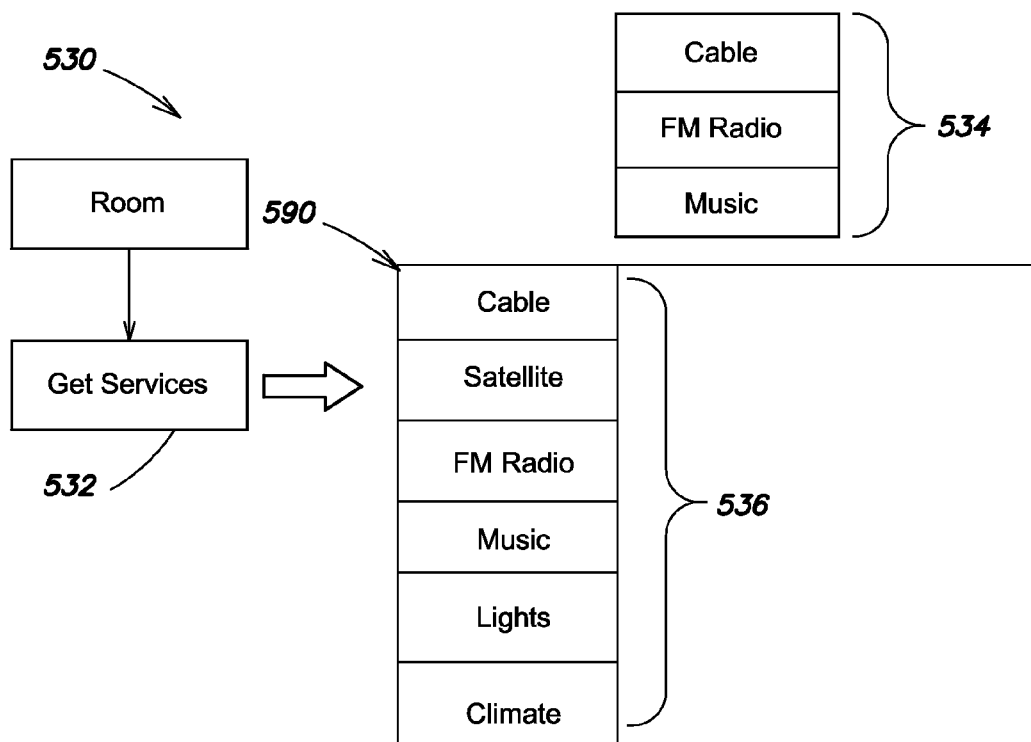
ZoneRoomMap				360
ID	Zone	Room		

**FIG. 3**

**FIG. 4****FIG. 5A**



**FIG. 5B**



**FIG. 5C**

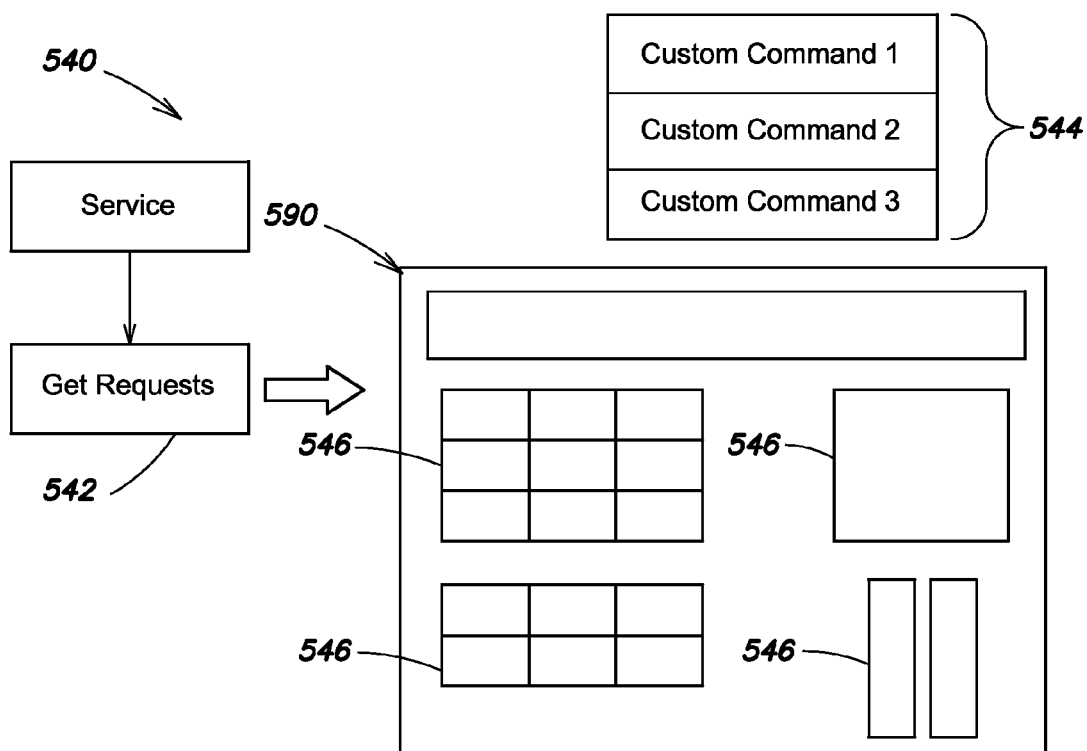


FIG. 5D

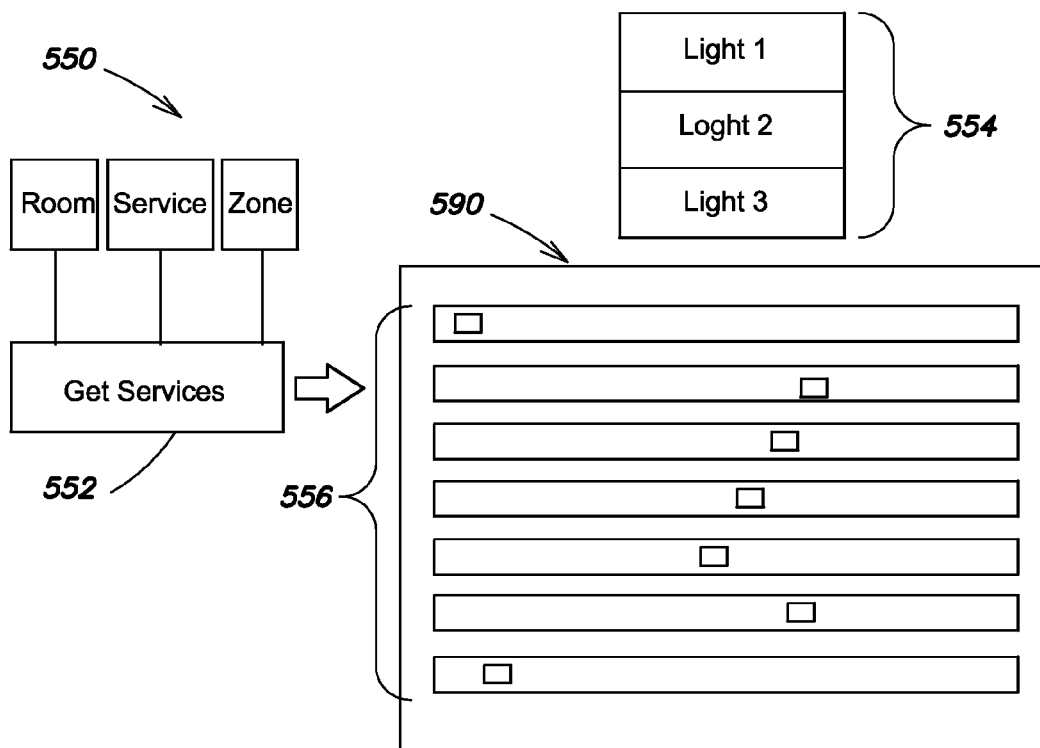
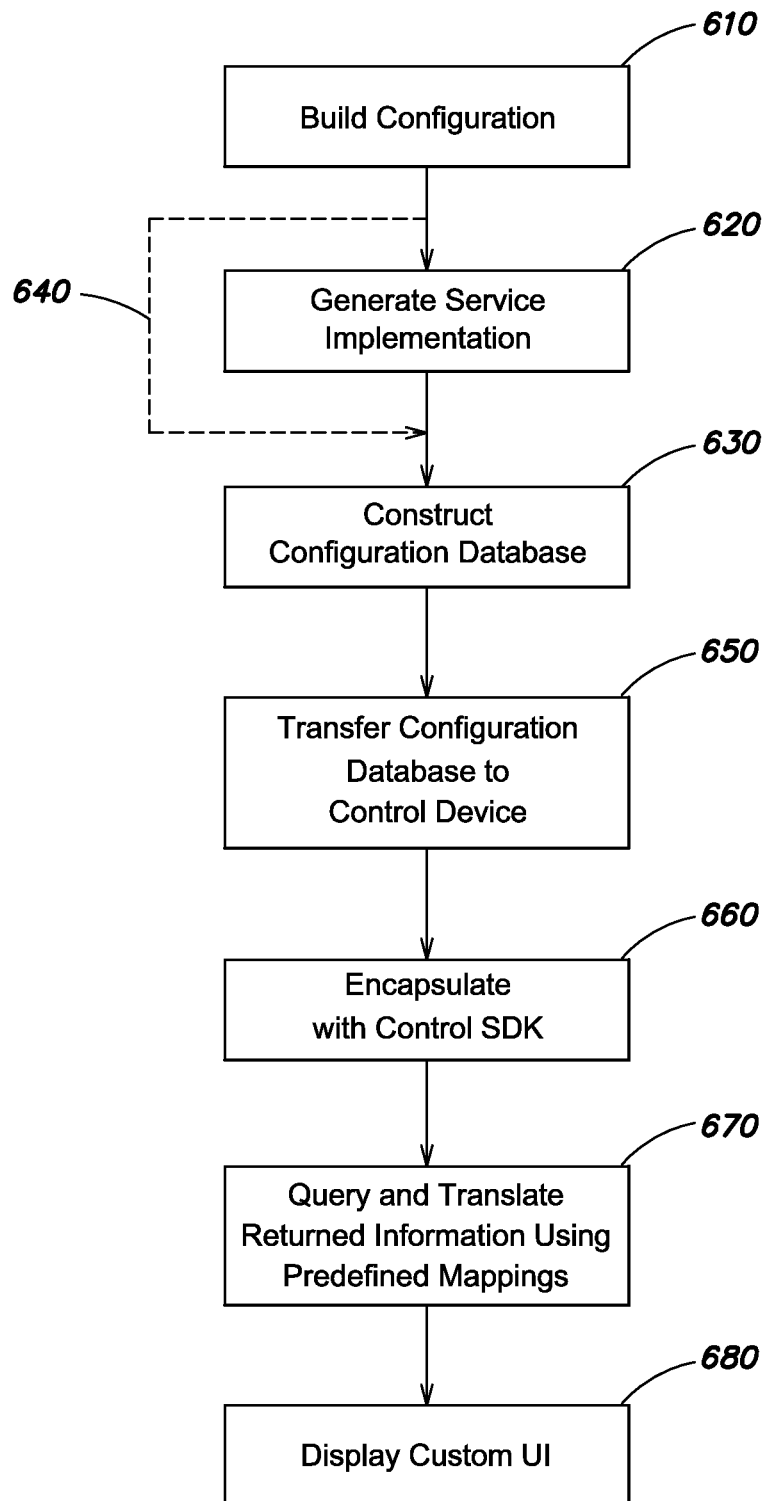


FIG. 5E



**FIG. 6**

# PROVIDING A USER INTERFACE FOR DEVICES OF A HOME AUTOMATION SYSTEM

## RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 14/282,734 entitled AUTOMATIC CONFIGURATION OF CONTROL DEVICE USER INTERFACE IN A HOME AUTOMATION SYSTEM, filed on May 20, 2014 by David W. Tatzel, et al., the contents of which are incorporated by reference in their entirety.

## BACKGROUND

### 1. Technical Field

The present disclosure relates generally to home automation systems and more specifically to the user interfaces (UIs) of control devices used in home automation systems.

### 2. Background Information

Home automation systems are becoming increasingly popular in both residential and commercial buildings. Such systems may be capable of controlling, switching data between, and otherwise interacting with a wide variety of devices, including audio/video devices (A/V) devices, heating ventilation and cooling (HVAC) devices, security devices, energy conservation devices, communications devices, telephony devices, and/or other types of devices. Often, a user may indicate desired control to a home automation system utilizing one or more control devices, for example, mobile devices (such as smartphones or tablet computers), remote control units that include a display screen (e.g., a touch sensitive display screen) upon which a user interface (UI) is shown, desktop computers (e.g., personal computers (PCs)), etc.

Prior to users being able to utilize a home automation system, such systems typically require configuration. Further control devices used with such system may require custom UI creation. Typically, an installer (e.g., a paid technician) connects to the system and builds a configuration using specialized software. The installer may then use specialized software to build a custom UI and/or adapt existing UI templates to produce a UI usable on a control device for controlling the configuration. For example, an installer may manually define UI elements (e.g., buttons, sliders, menus, etc.) and the functions of those UI elements. Even when UI templates are available, installers often need to make significant modifications to them before they are appropriate for use on a control device. This sort of manual building of a custom UI by an installer may be referred to as “installer-authoring.”

Installer-authoring of custom UIs for control devices has a number of shortcomings. Among other shortcomings, it is typically time consuming and error prone. The use of installer time generally adds to the overall cost of a home automation system, placing home automation beyond the reach of many consumers. Further, the potential for errors may lead to unreliability and user dissatisfaction with the home automation system.

Accordingly, there is a need for improved techniques for creation of custom UIs for control devices of home automation systems.

## SUMMARY

In one embodiment, a technique is provided to automatically generate custom UIs for control devices of a home automation system utilizing easily-digestible data formats

and translation abilities of a mobile application (app). After an installer has built a configuration of the home automation system in a configuration application, the configuration application constructs a configuration database (e.g., a relational database, such as a structured query language (SQL) database) that utilizes special logical representations to describe the configuration of the home automation system. The configuration database is transferred to (e.g., downloaded by) each control device, and may be encapsulated thereon by a control SDK. The control SDK, among other functionality, provides methods for querying the configuration database. A mobile app executing on the control device utilizes the control SDK to systematically query the configuration database, to retrieve information concerning the logical representations present and thereby the configuration of the home automation system. The mobile app then translates returned information to UI elements to create a custom UI of the mobile app, the translation using predefined mappings. The custom UI is displayed on the control device, for use by a user to control the home automation system.

Using such a technique, an installer need not author a custom UI for control devices used in the home automation system. The installer may simply configure the system. Upon a user activating a control device, the control device may obtain (e.g., download) the configuration database and automatically generate its own custom UI adapted to the configuration of the home automation system. Further, should the home automation system be reconfigured (e.g., devices added, operation of devices changed, etc.), an installer need not manually alter the custom UI to make use of the new functionality. A newer version of the configuration database may simply be obtained (e.g., download) onto each control device and used to automatically generate new custom UIs. As such, installer time (and thereby the overall cost of the home automation system), as well as the potential for introducing bugs due to human-error may be reduced.

It should be understood that a variety of additional features and alternative embodiments may be implemented other than those discussed in this Summary. This Summary is intended simply as a brief introduction to the reader, and does not indicate or imply that the examples mentioned herein cover all aspects of the disclosure, or are necessary or essential aspects of the disclosure.

## BRIEF DESCRIPTION OF THE DRAWINGS

The description below refers to the accompanying drawings, of which:

FIG. 1 is a block diagram of an example architecture of a home automation system operable to control devices about a structure;

FIG. 2A is a diagram illustrating a portion of a structure represented by an example room;

FIG. 2B is a diagram illustrating an example service that may be associated with the room of FIG. 2A;

FIG. 2C is a diagram illustrating an example workflow that may be used in the example service of FIG. 2B;

FIG. 2D is a diagram illustrating an example hierarchy of zones;

FIG. 3 is a diagram of a series of tables that are maintained as part of an example configuration database;

FIG. 4 is a block diagram of an example control software development kit (SDK);

FIG. 5A is a diagram illustrating use by a mobile app of an example “get room groups” method of the control SDK to obtain room groups, and translation of the room groups into UI elements of a custom UI of the mobile app;

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FIG. 5B is a diagram illustrating use by the mobile app of an example “get rooms” method of the control SDK to obtain rooms, and translation of the rooms into elements of the custom UI;

FIG. 5C is a diagram illustrating use by the mobile app of an example “get services” method of the control SDK to obtain services, and translation of the services into UI elements of the custom UI;

FIG. 5D is a diagram illustrating use by the mobile app of an example “get requests” method of the control SDK to obtain requests, and translation of the requests into UI elements of the custom UI;

FIG. 5E is a diagram illustrating use by the mobile app of an example “get entities” method of the control SDK to obtain entities and translation of the entities into UI elements of the custom UI; and

FIG. 6 is a flow diagram of an example sequence of steps for automatic generation of custom UIs.

### DETAILED DESCRIPTION

#### An Example Home Automation System

FIG. 1 is a block diagram of an example architecture of a home automation system **100** operable to control devices about a structure (e.g., a home or commercial building). At the core of the system **100** are one or more device controllers **110** and a host controller **140**. The device controllers **110** operate to switch signals between and provide low-level control to a variety of interconnected devices and/or subsystems **120-132**. The host controller **140** controls and monitors operations of the device controllers **110**, as well as provides user UI interpretation, system administration and monitoring, and/or other high-level control functions. Custom UIs for interacting with the home automation system **100** may be displayed to users on a variety of types of control devices **150**. Further, the home automation system **100** may be configured by an installer (e.g., prior to initial use, or upon a change to the system) using a configuration application **180** that may be executed on a separate computer **170**, that is, at least temporarily be coupled to the home automation system **100**.

More specifically, the device controllers **110** may provide N×N switching, audio and video processing, device control, and other management functions to the various device and/or subsystems **120-132** that are present. The devices and/or subsystems **120-132** may include A/V devices **120** categorized into source devices that originate audio and/or video signals (such as cable boxes, digital video disc (DVD) players, media players, etc.), processing devices that manipulate audio and/or video signals (such as pre-amps, digital signal processors, amplifiers, etc.), and output devices that output audio and/or video signals (such as televisions, speakers, projectors, etc.). The devices and subsystems **120-132** may also include lighting devices **122**, such as a lighting controller, keypads and/or lamp modules, and the like. In addition, heating ventilation and cooling (HVAC) devices **124** may be provided that include one or more thermostat processing units, thermostats, sensors and the like. Security devices may also be coupled to the device controllers **110**, including motion sensors, security cameras, home healthcare sensors, related controllers, etc. Further, shade control devices **128** may be provided that include motor operated window shades, motor operated window blinds, related controllers, etc. Energy conservation devices **130** may be provided that include one or more energy monitors, current transformers, voltage sensors and the like. Still further, a communications subsystem **132** may be present that provides telephony, intercom and other related

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functions, utilizing one or more private branch exchanges (PBXs), gateways, handsets, and other units.

The host controller **140** may maintain a state center that stores feedback describing the operation of the devices and subsystems **120-132**, and may provide state to the control device **150** that have registered to receive updates. Further, the host controller may receive control commands from control devices **150** indicating user input received in custom UIs shown on the control devices. The host controller **140** may interpret such commands and send messages to the device controllers **110** to implement activities the user may desire to participate in.

Each control devices **150** may execute an application, for example a mobile application **160**, that presents a custom UI to a user, and relays control commands back to the host controller **140**, for example, over a wireless (e.g., wireless local area network (WLAN), or wired (e.g., Ethernet) connection. Control devices **150** may take a variety of forms, including mobile devices **152**, remote control units **154**, desktop computers (e.g., PCs), etc. As used herein, the term “mobile device” refers to a general purpose electronic device that executes a general-purpose operating system and is adapted to be transported on one’s person. Devices such as tablet computers (e.g., the iPad® tablet running an iOS® operating system) and smartphones (e.g., the iPhone® smartphone running an iOS® operating system or an Android® smartphone running an Android® operating system) are considered mobile devices. Desktop computers would generally not be considered mobile devices. As used herein, the term “remote control unit” refers to a portable special-purposes electronic device that is configured to control a home automation system, or a portion thereof. Typically a remote control unit is not suited for general-purpose operation, and is instead adapted to operate with a one or more types of a home automation systems.

Regardless of their type, control devices **150** typically include a processor configured to execute software and manipulate data from data structures, and a memory including storage locations for storing the software and the data structures. Further, control devices **150** typically include a display screen (e.g., a touch sensitive display screen), for example, upon which the custom UI is shown. Control devices may also include a variety of other types of hardware, including a portable power source (e.g., a battery), a wireless communications interface, input devices (e.g., buttons, a camera, an orientation sensor, etc.), and the like.

As part of the initial installation of the home automation system **100**, or reconfiguration of the system, an installer may build a configuration of the system by defining the capabilities and interconnections between devices present in the system. A computer **170** executing a configuration application **180** may, at least temporary, be coupled to the home automation system **100**, and used by the installer. One example configuration application **180** that may be employed is the RacePoint Blueprint™ home automation software that provides a graphical programming environment for configuration of home automation systems. Using such an application, the installer may select representations of devices having corresponding profiles, place the representations in a workspace, and use a drawing tool to draw connections among the representations, as well as other operations, to build the configuration. From the built configuration the configuration application **180** may generate a “service implementation” **181**. A “service implementation” is a machine readable markup language representation (e.g., an Extensible Markup Language (XML) representation) of the configuration of a home automation system.

### An Example of Automated Generation of Custom UIs for Control Devices

In one embodiment, a technique is provided to automatically generate custom UIs for control devices **150** of the home automation system **100**. A conversion engine (e.g., of the configuration application **180**) may convert a service implementation **181** into a configuration database (e.g., a relational database such as a structured query language (SQL) database) **190**, a copy of which may also be maintained on the host controller **140**. The configuration database utilizes special logical representations to describe the configuration of the home automation system. To produce a custom UI on a given control device **150**, the configuration database is transferred to (e.g., downloaded by) the control device and encapsulated by a control SDK **400**. The control SDK **400**, among other functionality, provides methods for querying the configuration database **190**. A mobile app **160** executing on the control device utilizes the control SDK **400** to systematically query the configuration database **190**, to retrieve information concerning the logical representations present and thereby the configuration of the home automation system **100**. The mobile app **160** then translates returned information to UI elements to create a custom UI of the mobile app **160**, the translation using predefined mappings. The custom UI is displayed on the control device **150**, for use by a user to control the home automation system **100**.

The logical representations employed within the configuration database **190** may include “rooms”, “room groups”, “components”, “services”, “requests”, “workflows”, “environmental services”, “entities”, and “zones”, among others. In this context, a “room” refers to a logical representation of a portion of a structure in which a user may participate in one or more provided home automation activities. A room may correspond to a physical room within the structure or another region of space. For example, a user may participate in an activity of watching cable television (a “Cable TV” activity). Devices that are used to realize the activity may or may not be located in the portion of the structure represented by the room. For example, certain devices may be located in a central location (e.g., a rack room) and remotely signal into the portion of the structure.

FIG. 2A is a diagram **200** illustrating a portion of a structure represented by an example room. The example room **200** roughly corresponds to a physical living room within the structure, and includes devices such as a television **202**, speakers **204**, a cable box **206**, a digital media player **210**, and lighting fixtures **212**, which may allow a user to participate in various activities within the room **200**.

A “room group” refers to a logical representation of a set of rooms. Room groups may be based on physical proximity (e.g., being on the same floor of a structure), functional similarity, or other motivations.

A “component” refers to a logical representation of a device associated with a room. A “component” may be associated with a profile, e.g., a machine readable markup language (e.g., XML) description of the device’s capabilities and input/output (I/O) interfaces.

A “service” refers to a logical representation of an activity a user can participate in. Generally, a service corresponds to one or more unique paths between devices that implement a set of functionality (e.g., audio and video paths from source devices to output devices). A service often defines a list of commands and state feedback which a control device **150** may use.

FIG. 2B is a diagram **210** illustrating an example service that may be associated with the room of FIG. 2A. The example service may be a “Cable TV” service that utilizes the

cable box, television and speakers shown in FIG. 2A, as well as a media switch, and receiver (not shown). A video path of the example service passes between the cable box, the media switch, and the television, while an audio path of the example service passes between the cable box, the media switch, the receiver and the speakers.

A “request” (or “service request”) refers to a logical representation of a command supported by a service. For example, a request of the above discussed “Cable TV” service may be “channel up”, “channel down”, “menu”, etc.

Further, a “workflow” refers to a logical representation of sequential actions that are performed by devices to implement a command of a service. Workflows may be standardized, or may be customized to include custom actions particular to an individual home automation system **100**.

FIG. 2C is a diagram **220** illustrating an example workflow that may be used in the example service of FIG. 2B. The example workflow may be a “Cable Box Power On” workflow used by the above discussed example “Cable TV” service. The example workflow includes a sequence of actions that turn on the cable box, make an internal audio connection in a media switch, make an internal video connection in the media switch, turn on a receiver, select an input on the receiver, turn on a television, and select an input on the television.

In addition, an “environmental service” is a special type of service that logically represents non-A/V activities. Example environmental services may relate to lighting, shades, HVAC control, security, or other sorts of control.

Further, an “Entity” (or “environmental entity”) refer to a logical representation of a controllable device that provides an environmental service. For example, an entity of a lighting service may represent a dimmer, switch, or other lighting control device; an entity for a shades service may represent a motor operated window shade, blind or other controllable window covering; likewise, an entity for an HVAC service may represent a thermostat or other HVAC device.

Finally, “zones” refer to a logical representation of a set of home automation system functionality. Several different types of zones may be employed. A “control zone” may organize functionality in terms of a group of contained services. An “environmental zone” may organize functionality in terms of a portion of a structure affected by a particular environmental service. Further, a “UI zone” may organize functionality in terms of what is to be displayed together to a user in a UI. Zones may be simultaneously of multiple types. For example, a given zone may be both a control zone and a UI zone. Further, zones may have a hierarchical relationship with each other.

FIG. 2D is a diagram **230** illustrating an example hierarchy of zones. In this example, a UI Zone “1<sup>st</sup> Floor” includes a UI zone “Office” and a zone “Kitchen” that is both a control zone and a UI zone. The UI zone “Office” includes a control zone “Office TV1”, a second control zone “Office TV2”, an Environmental Zone “Office Lighting” and an environmental zone “1<sup>st</sup> Floor HVAC”. Likewise, in this example, the zone “Kitchen” may include the environmental zone “1<sup>st</sup> Floor HVAC.”

Information describing the logical representation may be maintained within the configuration database **190**. FIG. 3 is diagram of a series of tables that are maintained as part of an example configuration database **190**. A “rooms” table **310** may store data describing rooms, and include an identifier (ID) that serves as a primary key, and a unique room name. A “room groups” table **320** may store data describing room groups, and include an ID that serves as a primary key, and a group name. A “zones” table **330** may store data describing

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zones, and include an ID that serves as a primary key, and a zone name, and a type of the zone. A “room group map” table **340** may store an explicit mapping of rooms to rooms groups, and include an ID that serves as a primary key, a room ID that references a room from the rooms table **310**, and a group ID that references a group of the room groups table **320**. A “zone service map” table **350** may store an explicit mapping of zones to services, and include an ID that serves as a primary key, a zone name, and a service ID that references a service stored in a “services” table (not shown). Still further, a “zone room map” table **360** may store an explicit mapping of zones to rooms, and include an ID that serves as a primary key, a zone name, and a room ID that references a room stored in the rooms table **310**. It should be understood that the configuration database **190** may also include a large number of other tables, and that tables **310-360** are merely illustrative of the type of arrangement of data that may be employed.

A copy of the configuration database **190** may be maintained on the host controller **140**, and transferred (e.g., downloaded) to a control device **150** when the control SDK **400** on the control device **150** detects the version on the configuration database **190** is newer than one already present on the control device **150** (or no configuration database is present on the control device **150**). The control SDK **400** may further encapsulate the copy of the configuration database **190**, thereby providing an interface for querying it.

FIG. 4 is a block diagram of an example control SDK **400**. A control object **410** may operate as a high level object, and include other objects of the SDK **400**. A discovery object **420** is configured to find home automation systems on a local network and, for example, identify information about them such as a unique ID (UID) and an address. A connection object **430** is configured to connect to a designated home automation system **100**, for example, using the UID or address, and handle such tasks as tracking connection status, managing authentication and user lists, pausing and resuming connections, and the like. The connection object **430** may be responsible for downloading the configuration database **190** to the control device **150** when it is determined that the host controller **140** includes a newer version than already present on the control device **150** (or no configuration database is present). Additionally, the connection object **430** may send messages to the host controller **140** as part of ongoing control of the home automation system, including sending service requests, on-screen display (OSD) commands, media request, etc. Similarly, the connection object **430** may receive state information from the host controller **140** during ongoing operation of the home automation system, for example, state feedback for system states the control device **150** has registered to receive.

A data object **440** is configured to encapsulate the configuration database **190** on the control device **150** and provide methods to support a variety of queries. A “get room groups” method may be provided to obtain all room groups. A “get rooms” method may be provided to obtain rooms that are associated with a specified room group. Further, a “get services” method may be provided to determine offered services that are associated with a specified room. Likewise, a “get requests” method may be provided to obtain requests that are associated with a specified service. Requests may be filtered to return only those that can be enabled. A “get zones” method may be provided to obtain zones that are associated with a service. Still further, a “get entities” method may be provided to obtain entities associated with a specified room, service and zone.

The mobile app **160** executing on the control device **150** may utilize the control SDK **400**, and the methods provided

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by the data object **440** thereof, to systematically query the configuration database **190**, to retrieve information concerning the logical representations present, and thereby the configuration of the home automation system **100**. The mobile app **160** then translates the returned information to UI elements using predefined mappings

FIG. 5A is a diagram **510** illustrating use by the mobile app **160** of an example “get room groups” method **512** of the control SDK **400** to obtain room groups **514**, and translation of the room groups into UI elements **516** of a custom UI **590** of the mobile app. In this example the “get room groups” method **512** returns three room groups **514**, named “Basement”, “First Floor”, and “Second Floor”. The mobile app **160** translates the returned room groups into UI elements (e.g., buttons) **516**, labeled “Basement”, “First Floor”, and “Second Floor”, located in a first predetermined portion of a page of a custom UI **590** of the mobile app **160**. The UI elements **516** are user-selectable (e.g., by touch) to cause the display of rooms that are members of the respective room group.

FIG. 5B is a diagram **520** illustrating use by the mobile app **160** of an example “get rooms” method **522** of the control SDK **400** to obtain rooms **524**, and translation of the rooms into UI elements **526** of the custom UI **590**. The “get rooms” method **522** may take as an argument a room group. In this example, the “get room groups” method **522** is provided as an argument the room group of “First Floor”, and returns rooms **524** named “Living Room”, “Kitchen”, “Office”, etc. The mobile app **160** translates these the returned rooms into UI elements (e.g., buttons) **526**, labeled “Living Room”, “Kitchen”, “Office”, etc., that are located in a second predetermined portion of the same page of the custom UI **590** of the mobile app **160**. The UI elements **526** are user-selectable to cause the display of services that are offered.

FIG. 5C is a diagram **530** illustrating use by the mobile app **160** of an example “get services” method **532** of the control SDK **400** to obtain services **534**, and translation of the services into UI elements **536** of the custom UI **590**. The “get services” method **532** may take as an argument a room. In this example, the “get services” method **532** is provided the argument of “Living Room”, and returns services **534** named “Cable”, “FM Radio”, “Music”, etc. The mobile app **160** translates the returned services into UI elements (e.g., buttons) **536**, labeled “Cable”, “FM Radio”, “Music”, etc., located in a predetermined portion of another page of the custom UI **590** of the mobile app **160**. The UI elements **536** are user-selectable to cause the display of commands related to the respective service.

FIG. 5D is a diagram **540** illustrating use by the mobile app **160** of a “get requests” method **542** of the control SDK **400** to obtain requests **544**, and translation of the requests into UI elements **546** of the custom UI **590**. The “get requests” method **542** may take as an argument a service. In this example, the get requests method **542** is provided the argument of “Cable”, and returns requests related to controlling a cable television viewing activity. The mobile app **160** translates the returned requests into UI elements (e.g., buttons, sliders, menus, etc.) **546** representing commands located on another page of the custom UI **590** of the mobile app **160**. The UI elements **546** are user-selectable to trigger the related commands.

FIG. 5E is a diagram **550** illustrating use by the mobile app **160** of an example “get entities” method **552** of the control SDK **400** to obtain entities **554**, and translation by the mobile app **160** of the entities into UI elements **556** of a UI **590**. The “get entities” method **552** may take as arguments a room, a service and a zone, and returns entities. The mobile app **160**

translates the returned entities into UI elements (e.g., sliders, buttons, knobs etc.) **556** usable to control the related entity. The UI elements may be displayed on yet another page of the custom UI **590** of the mobile app **160**. The UI elements **556** are user-selectable to indicated desired control of the related entities.

FIG. 6 is a flow diagram of an example sequence of steps **600** for automatic generation of custom UIs. At step **610**, in response to input from an installer, a configuration application **180** executing on a computer **170** builds a configuration of a home automation system **100**. At step **620**, the configuration application **180** generates a service implementation **181**. At step **630**, the configuration application **180** (or a separate software process) constructs a configuration database **190** that employs the above discussed logical representations, e.g., by translating the service implementation. Alternatively, the configuration database **190** may be directly constructed from the configuration built within the configuration application **180**, absent the intermediary step **620** of generation of a service implementation, as shown by alternate pathway **640**.

At step **650**, the configuration database **190**, or a portion thereof, is transferred (e.g., downloaded) to a control device **150**. The transfer may occur from a host controller **110** where the configuration database **190** is maintained, and be in response a determination that a newer version of the configuration is available (or no configuration database is present on the control device **150**). At step **660**, the configuration database **190** is encapsulated on the control device **150** by a control SDK **400** that provides an interface for querying the configuration database **190**. At step **670**, a mobile app **160** executing on the control device **150** utilizes the control SDK **400** to query the database and translate returned information using predefined mappings to UI elements of a custom UI of the mobile app **160**. At step **680**, the custom UI is displayed on the control device **150**, permitting a user of the control device to control the home automation system **100**.

It should be understood that various adaptations and modifications may be made within the spirit and scope of the embodiments discussed herein. While some of the embodiments involve a home automation system that is capable of A/V control, lighting control, HVAC control, and other types of control, it should be understood that the techniques may be applicable more limited systems that, for example, may be controlling only a single type of device (e.g., only A/V devices, only lighting devices, etc.). While some of the embodiments utilize a mobile app **160** to perform various ones of the operations described above, it should be understood that the operations of the mobile app **160** may be implemented other software and/or hardware. For example, operations may be performed by client-side or server-side web code in connection with a web-based user interface. Similarly, operations may be performed by a personal computer (PC) based application. Further, it should be understood that in different embodiments software may be executed on different hardware devices than as shown above.

In general, many of the techniques may be alternatively implemented in software, in hardware, or various combinations thereof. Software implementations may include machine-executable instructions (e.g., computer-executable instructions) stored in a non-transitory machine-readable medium (e.g., a non-transitory computer-readable medium), such as a volatile or persistent memory, a hard-disk, a compact disk (CD), or other tangible medium. Hardware implementations may include configured processors, logic circuits, application specific integrated circuits, and/or other types of hardware components. Further, combined software/hardware

implementations may include both computer-executable instructions stored in a non-transitory computer-readable medium, as well as one or more hardware components, for example, processors, memories, etc. In general, it should be understood that the above descriptions are meant to be taken only by way of example.

What is claimed is:

**1.** A method of providing a custom user interface (UI) for a plurality of devices of a home automation system within a structure, comprising:

constructing a configuration database that stores logical representations that describe a configuration of the plurality of devices of the home automation system, the plurality of devices including at least one audio/video device, lighting device, heating ventilation and cooling (HVAC) device, security devices, shade control device, or energy conservation device located within the structure, the logical representations stored in the configuration database to include:

components that represent the plurality of devices of the home automation system,

services that represent activities a user can participate in and that are provided by one or more of the plurality of devices of the home automation system,

rooms that represent portions of the structure to which one or more of the plurality of devices of the home automation system provide services, and

zones that represent sets of home automation system functionality;

maintaining the configuration database on an electronic device;

finding and connecting to the configuration database by a mobile application (app) executing on a mobile device; querying the configuration database by the mobile app; and based on the querying, generating, by the mobile app, a custom user interface (UI) that is presented to the user on a display screen, wherein the custom UI is usable to control one or more of the plurality of devices of the home automation system.

**2.** The method of claim **1**, wherein the logical representations stored in the configuration database further include:

workflows that represent actions executed by the plurality of devices of the home automation system that when executed implement at least portions of services.

**3.** The method of claim **2**, wherein at least one of the workflows is customized to implement actions unique to the configuration of the home automation system, and at least one of the workflows is standardized to implement actions common to the configuration of multiple different home automation systems.

**4.** The method of claim **1**, further comprising determining that the configuration database has been updated to indicate a new configuration of the plurality of devices of the home automation system; and

in response to the determining that the configuration database has been updated, providing updated information from the updated configuration database to the mobile app.

**5.** The method of claim **1**, wherein the maintaining the configuration database comprises sharing the configuration database among a plurality of electronic devices to provide consistent description of the configuration of the plurality of devices of the home automation system to different electronic devices.

**6.** The method of claim **1**, wherein the mobile device is a smartphone, and the display screen is part of the smartphone.

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7. The method of claim 1, wherein the mobile device is a tablet computer, and the display screen is part of the tablet computer.

8. The method of claim 1, wherein at least one of the zones represents a floor of the structure.

9. The method of claim 8, wherein the configuration database includes a data structure that maps the at least one of the zones to rooms.

10. The method of claim 1, wherein each component is associated with a profile that describes at least the represented device's capabilities and input/output (I/O) interfaces.

11. The method of claim 1, wherein each of the rooms is associated with a unique room name that is unique among the logical representations for the structure.

12. The method of claim 1, wherein each of the services includes commands or states that are controllable by the mobile app.

13. The method of claim 1, further comprising:

obtaining, by the mobile app, state information during ongoing operation of the home automation system; and  
presenting, by the mobile app, the state information in the custom UI.

14. A non-transitory electronic-device readable medium having instruction stored thereon, the instruction when executed by a processor being operable to:

maintain a configuration database that stores logical representations that describe a configuration of a plurality of devices of a home automation system of a structure, the plurality of devices including at least one audio/video device, lighting device, heating ventilation and cooling (HVAC) device, security device, shade control device, or energy conservation device of the structure, the logical representations stored in the configuration database to include:

services that represent activities a user can participate in and that are provided by one or more of the plurality of devices of the home automation system, and

rooms that represent portions of the structure to which one or more of the plurality of devices of the home automation system provide services;

provide a connection to the configuration database to a mobile application (app);

respond to a query to the configuration database from the mobile app, the response to include information usable by the mobile app to build a custom user interface (UI) that controls one or more of the plurality of devices of a home automation system;

update the configuration database to indicate a new configuration of the plurality of devices of the home automation system; and

provide updated information to the mobile app usable by the mobile app to build an updated custom UI that controls one or more of the plurality of devices of the home automation system.

15. The non-transitory electronic device readable medium of claim 14, wherein the logical representations stored in the configuration database further include:

components that represent the plurality of devices of the home automation system.

16. The non-transitory electronic device readable medium of claim 14, wherein the logical representations stored in the configuration database further include:

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zones that represent sets of home automation system functionality.

17. The non-transitory electronic device readable medium of claim 14, wherein the logical representations stored in the configuration database further include:

workflows that represent actions executed by the plurality of devices of the home automation system to implement at least portions of services.

18. The non-transitory electronic device readable medium of claim 14, wherein the instructions when executed are further operable to:

obtain state information during ongoing operation of the home automation system; and

present the state information in the custom UI.

19. A method for providing a custom user interface (UI) for a plurality of devices of a home automation system within a structure, comprising:

querying, by a mobile application (app) executing on a mobile device having a processor and a touch-sensitive display screen, a configuration database that stores logical representations that describe a configuration of the plurality of devices of the home automation system, the plurality of devices including at least one audio/video device, lighting device, heating ventilation and cooling (HVAC) device, security device, shade control device, or energy conservation device located within the structure, the logical representations stored in the configuration database to include:

components that represent the plurality of devices of the home automation system;

services that represent activities a user can participate in and that are provided by one or more of the plurality of devices of the home automation system,

rooms that represent portions of the structure to which one or more of the plurality of devices of the home automation system provide services, and

zones that represent sets of home automation system functionality;

based on the querying, generating a custom user interface (UI) of the mobile app usable to control one or more of the plurality of devices of the home automation system; and

in response to input in the custom UI, changing a state of one or more of the plurality of devices of the home automation system,

wherein the configuration database is updated in response to the changed state to reflect a new configuration of the home automation system.

20. The method of claim 19, wherein the logical representations stored in the configuration database further include:

workflows that represent actions executed by the plurality of devices of the home automation system to implement at least portions of ones of the services.

21. The method of claim 19, wherein the updated configuration database is shared with one or more other mobile devices.

22. The method of claim 19, further comprising:

maintaining the configuration database on the mobile device.

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